REPARATION

OF

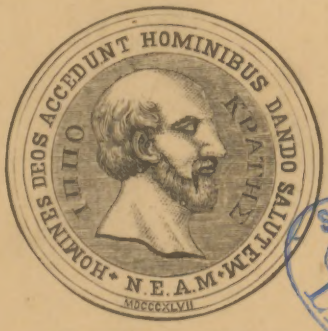
BRAIN-TISSUE AFTER INJURY.

BY

JOHN P. GRAY, M. D., LL.D.,

MEDICAL SUPERINTENDENT OF THE NEW YORK STATE LUNATIC ASYLUM, UTICA, N. Y.

[*REPRINTED FROM THE TRANSACTIONS OF THE NEW YORK ACADEMY OF MEDICINE.*]



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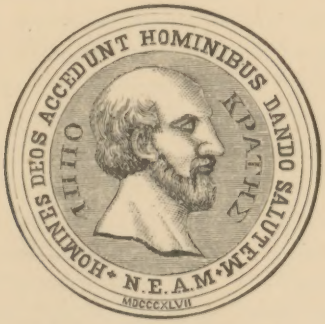

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Read February 18, 1875.

In February, 1868, I saw, with Dr. Edwin Hutchinson, of Utica, a case of fracture of the cranium, in H. Galli, a boy three years old. He had fallen against a stove, striking the right side of his head. No unconsciousness followed; when we saw him he was sitting on his mother's lap, not complaining, and the side of his face was smeared over with brain-substance. Examination revealed fracture of the anterior portion of the right parietal bone, a piece of which, more than an inch in diameter, had been driven into the brain, standing at right angles with the surface, with one edge still adherent. It had torn through the membranes, and lacerated the brain-substance, a portion of which had been forced through the opening. After laying back the scalp by a V-incision, the tearing up of the brain-convolutions was very apparent. Elevating the bone forced out a quantity of brain-substance. When the edges of the wound were brought together, a small opening remained in the cranium, where an irregular piece had been broken off. For seven days the child continued quite comfortable; a little fever, but pulse not rising above 132; appetite good, and did not complain of pain.

On the seventh day he became restless, head hot, some discharge of thin pus; pulse rose to 140. This condition continued for three days, when the flow of pus ceased and the ragged membranes projected through the opening. The child was dull and somnolent. The wound was carefully explored with a probe, and the projecting membranes clipped

off. This was followed by a small discharge of pus, and on the following morning the pulse fell to 116; heat of head lessened; the boy brighter.

On the eleventh day there were twitchings about the right eye, and the eyeballs were in constant oscillation horizontally.

On the twelfth day there were loss of movement and lowering of temperature in left arm; pulse 112 when awake and 100 when asleep; skin was cool, tongue moist, and urine free; child restless, crying, and at times screaming. A probe was again passed into the wound, and a free discharge of dark-colored pus followed, with some broken-down brain-tissue. Immediately after, Dr. Hutchinson removed a spicula of bone which had been embedded some two inches in the brain, and the child brightened up.

On the fourteenth day, pulse 98, movement of the eyeballs ceased, and slight motion and increase of temperature appeared in the left arm. Quite a free discharge of pus.

On the sixteenth day, movement in arm returned and child bright; flow of pus continued.

On the twentieth day, a small growth protruded through the opening, and, increasing, pressed the piece of bone backward and downward. This mass was again cut away. It was rapidly renewed, however, and was again cut away on the twenty-first, twenty-third, and twenty-fifth days.

On the thirty-first day a protrusion, the size of a pigeon's egg, was cut away.

On the thirty-second day a still larger mass was removed.

On the thirty-third day some hæmorrhage occurred.

On the thirty-seventh day the protruding mass was the size of a large hen's egg.

On the forty-fourth day the mass was tied off, for fear of hæmorrhage.

On the forty-sixth day a protruding mass was again cut away.

On the forty-eighth day a flow of serum commenced, which continued until the fifty-third day, during which over

two pints was discharged. During all this time the child was bright but fretful, took food, pulse ranging from 120 to 144.

On the fifty-eighth day the protruding mass remained stationary, its broad base filling the opening, firm, of a light pink color, and resembling brain-tissue. Child deaf, walks unsteadily.

On the sixty-eighth day, general health improved, child walks alone: all the general symptoms have subsided. The mass has the appearance of brain-convolutions.

On the sixty-ninth day Dr. Hutchinson commenced slight pressure, by a cork pad, held by a rubber band passed around the head, such as is used around packages of letters, and in a few days, without any unpleasant symptoms, the mass passed within the cranium.

On the eighty-eighth day it was covered with membrane.

On the ninety-eighth day the scalp had nearly healed over.

On the one hundred and twelfth day the child was entirely well, but deaf.

In this case, considering the age of the child, the loss of brain-substance was large. During the inflammatory process, while the injured brain-tissue was being discharged, the amount of connective-tissue elements produced and cut away was very great.

Dr. S. Weir Mitchell, in speaking of the pathological results of neuritis after injury to nerves, says there is "an enormous development of connective-tissue elements."

The length of time in reparation of tissue in this case quite corresponds with reparation of nerves after injuries.

The new and final growth was the reformation of brain-matter filling up the space. It was some twenty days in completing its structure, and the convolutional character of the surface was distinctly marked. My impression is, that it would have passed into the cranium *without* the slight pressure used.

If, after the section of a nerve, the upper end should be

renewed by the formation of a button-like growth, and, if reparation is a law of the organism, why should the brain be an exception? Was the brain-tissue reproduced, or the space simply filled with amorphous matter? It was a long time before the reproduction of nerve-tissue was accepted; yet, nerve-fibres were reunited and reproduced in the healing of wounds and fractures, and in cases of destruction of tissue by abscess or ulcerative processes.

This boy is now ten years old, a bright, active lad; is deaf, and is being educated at the Institution for Deaf Mutes in New York City. The case was under the charge of Dr. Edwin Hutchinson, who conducted it with great skill, and whose reported notes I have freely drawn upon.

The second case is that of a man, a soldier, who at the age of forty-one, in September, 1862, was wounded in the head at the battle of Antietam. The ball struck the posterior part of the right parietal bone, crushing it in, leaving an opening in the skull one and a half inch in antero-posterior diameter, and three inches in the vertical line. The ball was embedded in the substance of the brain. Forty-eight pieces of bone were taken from the brain; the bullet was removed ten days after the injury. He was discharged from the service and pensioned in 1863, and entered upon his occupation as a turner in brass, the wound having entirely healed over. For five years he remained in good health, without even suffering from headaches. His general health became impaired in October, 1868, and he became depressed, and finally developed an attack of melancholia.

He was admitted to the asylum at Utica, February 3, 1871, where he remained until February 15, 1872, having then been well about four months. He was discharged recovered, and returned home and to his work. Nine months afterward he began to suffer from pain in the head, especially over the frontal region. He complained of confusion of mind, and asked to be again received at the asylum, dreading a return of melancholia. In April, 1873, this condition continu-

ing, he applied for an order, and came to the asylum alone with the papers of commitment. June 14th, two months after admission, he became profoundly melancholic. He gradually failed, and died July 25, 1873.

On *post mortem*, an elliptical opening in the right parietal bone was found, corresponding to the wound already described.

No attempt at bone-reparation had been made. The dura mater extended over the opening, and was firmly adherent to the scalp. The arachnoid and pia mater were so completely renewed that no trace of the injury could be detected in their structure or by the presence of cicatrices.

The convolutions were fully outlined, and resembled in appearance the other convolutions of the right hemisphere. Vertical sections through these repaired convolutions showed the normal proportion of gray and white matter.

As the pathological result of the attack of insanity, the dura mater was somewhat thickened, and showed signs of recent inflammatory action. The pia mater of a large part of the right hemisphere was opaque, and raised by an effusion of serous fluid, containing lymphoid cells and pus corpuscles.

The whole brain was dry, atrophied more or less, but especially the convolutions of the right side. Each ventricle contained half an ounce of serum. The brain weighed thirty-eight ounces. The walls of the vessels of the convolutions, in certain areas, were distended by crystalline deposits of cholesterine, and structureless, translucent bodies of an albuminous character. Amyloid degeneration was found in the walls of the vessels of the pons Varolii and the medulla. The nerve-cells of the outer layers of the gray substance were contracted and opaque. The fibres of the white substance thicker than usual, and the neuroglia lessened.

In the atrophied gray cortex of the anterior and posterior ascending parietal convolutions of the right hemisphere, the nerve-elements were much diminished in number, in comparison with the corresponding parts of the left hemisphere. This condition was especially marked in regard to the pyramidal

cells of the second of the five layers of the cortex. The connective elements were more dense, fibrillous in their structure, and densely colored by carmine.

In the middle and inferior frontal convolutions, down to the convolutions of the Sylvian fissure and the island of Riel, there was large infiltration of pigment.

In this case, as in the other, the brain-reparation was complete, and the man remained well for five years. The pathological results of the attack of insanity were similar to those ordinarily found.

Theodore Simon (Virchow's "Archives") reports two cases of what he denominates additional brain-growths, where new formations were found superincumbent upon the gray matter of the convolutions. In these new growths the gray and white matter were normal in their relations and proportions. They probably originated from slight injuries.

Pathological history affords a large number of injuries to the brain, with loss of brain-substance and subsequent recovery, though there have been comparatively few cases where they have been followed through life, and the brain examined after death.

Among the most interesting cases is that of Phineas Gage, which occurred in Vermont, September 13, 1848, and is given in detail in the descriptive catalogue of the Warren Anatomical Museum of Boston. The skull is now in the museum. A tamping-iron, a cylindrical iron bar, one and a quarter inch in diameter, three feet and seven inches in length, and weighing thirteen and a quarter pounds, passed through his head while he was tamping a charge for blasting rocks. One end of the bar was square, the whole tapering to a quarter of an inch at the opposite end. It entered "in front of the angle of the lower jaw, upon the left side," by the smaller end, and passed out through the anterior and upper part of the left parietal bone. It traversed "the anterior part of the left hemisphere, and across the corpus callosum and the margin of the right hemisphere, involving the loss of the central part of the left anterior lobe, together with extensive

laceration of the middle lobe, the right central lobe, the falx, and the longitudinal sinus." Here was an immense loss of substance.

In this case, as in the boy Galli, a large fungous growth appeared in the progress of the case, and was cut away; there was also discharge of pus and broken-down brain-tissue.

On the fifty-sixth day he was so far recovered as to be walking about.

On the sixty-second day he walked half a mile.

On the seventy-third day he went to his home, a distance of thirty miles.

On the one hundred and ninth day "the wound was quite closed."

It will be observed that the progress of brain-restoration in these two cases is quite similar.

He lived twelve years, some two years of which he traveled with the bar and exhibited himself—then acted as a hostler. In 1852 he went to South America and drove a stage-coach. In June, 1860, he returned to San Francisco, with impaired health, where he worked on a farm, till he died of convulsions on the 20th of May, 1861.

It is to be regretted that the record is silent in regard to the condition of the brain. The probability is, that the space was so completely filled up as not to attract the attention of those who made the *post mortem* and preserved the skull.

I have seen three cases of attempt at suicide by shooting, where the ball entered the brain and remained there, and where recovery took place. In each case the external wound was *kept open*, and pressure prevented during the progress of reparation.